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IDENTIFICATION OF CRITICAL BARRIERS OF INDUSTRIALISED BUILDING SYSTEM (IBS) IN CONSTRUCTION INDUSTRY: ANALYSIS USING THE ANALYTICAL HIERARCHY PROCESS (AHP)

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ABSTRACT

Industrialised Building System (IBS) is one of the system that was widely used in construction since 1960. Many benefits when apply the IBS in construction but the level of construction in rural areas is still using conventional method compare than Industrialised Building System (IBS). The use of conventional method in rural area can cause a project take time to complete, produce the poor construction quality, and all the materials will be placed at the construction site. The purpose of this study to determine barriers to IBS implementation and identify the critical barriers that preventing the implementation of IBS in rural area projects. The methodology used is Analytical Hierarchy Process (AHP) method, in which set of questionnaire based on the pairwise comparison method are distributed to selected respondents. From this study, the result show that barriers for implementing IBS in rural area projects are quality design, cost, materials, building design, security of building, labour cost, environment control cost, quality of materials, materials cost, reliability of building, transportation cost, flexibility design of building, tangibility of building, supply of materials, and creativity design of building. The result also identify quality design as the most critical barrier that need further consideration the contractors. Expected findings of this study is for the policy makers or company may use the findings or guideline to formulate new policy or strategy in construction industry. In future research, the number of respondent are involve should be large to generalised the idea.

Keywords – Industrialised Building System (IBS), Analytic Hierarchy Process (AHP), construction industry, rural area

INTRODUCTION

Nowadays, the construction sector is most important industry due to the increasing demand for modern and efficient infrastructure, in line with the goals of develop countries, said the Economic Planning Unit in the office of the Prime Minister of Malaysia to the 11th Plan document. The growth of the construction sector, services and manufacturing is also expected to increase in 11th Malaysia Plan to drive the Malaysia towards a develop nation by 2020. According to the document, in the 11th Malaysia Plan period, the construction sector is projected to grow at 10.3% per year and contribute toRM327 billion or 5.5% or Gross Domestic Product (GDP) by 2020. According to news released by the Astro Awani on 10 September 2015, the Prime Minister of Malaysia, Datuk Seri Najib Tun Razak launched the Construction Industry Transformation Programme (CITP) before reaching 2020. According to him, the Construction Industry Transformation Programme (CITP) is part of the 11th Malaysia Plan, aims to create a sustainable construction industry in the country and compete in the international arena.

The construction industry globally has start to embrace Industrialised Building System (IBS) as a method of attaining better construction quality and productivity, reducing risks related to occupational safety and health, alleviating issues for skilled workers and dependency on manual foreign labour, and achieving the ultimate goal of reducing the overall cost of construction. Apart from this, it offers minimal wastage, fewer site materials, a cleaner and neater environment, controlled quality, and lower total construction costs. (Pan et al. 2008, Hamid et al. 2008 and Pan et al. 2007).

Undeniable, the use of Industrialised Building system (IBS) many benefits when apply in the field of construction. Therefore, the Industrialised Building System (IBS) should be apply in construction activities carry out in rural areas. But that's problem when most of the construction activities are carry out in rural areas using the conventional methods compare than Industrialised Building System. So, this study is undertaken to determine the critical barriers of Industrialised Building System (IBS) in rural area projects.

STATEMENT OF THE PROBLEM

The construction sector is a sector that has provided service to the people. For example, the construction of infrastructure. Every construction infrastructure most important especially now where all information should be always fast. Therefore, the people live in rural areas should be also tasted along with what obtained by people in the city so there is a balance and coordination between the two places. This can be evidence by the issues raised in the Tenth Malaysia Plan 2011-2015, which provides basic rural infrastructure, improve services delivery, strengthening of economic activity, encourage entrepreneurship and strengthen the community. So, in the 10th Malaysia Plan, we can see that the rural areas have not been spared than construction activity.

However, most of the construction project carried out in rural areas take a longer to complete. "Borneo Post Online" publish on May 15, 2015 stated that the road project linking 10 Malay Villages along the coast of the Limbang River is one example of the projects carried out in rural areas, which take longer to complete. Now, the issue has been included in the 11th Malaysia Plan. The level of construction in rural areas is still widely using conventional methods compare than the Industrialised Building System (IBS). The conventional method can cause the involvement of foreign labour directly in a project to accommodate the needs of the workforce. Indeed, the local labour is not enough to run a project.

Furthermore, conventional methods can cause all building materials will be placed at the construction of a project. All materials are placed on the construction site because all construction activities will be conducted at the project site. The activity construction that not use the Industrialised Building System (IBS) will produce the poor construction quality. This condition occur because an activity construction just only use the effort of foreign labour, not use the another alternatives likes high quality machine. To solve this problem, a study should be done to determine the critical barriers of Industrialised Building System (IBS) in rural area projects.

LITERATURE REVIEW

Definition of IBS

Industrialised Building System (IBS) through Construction Industry Development board (CIDB) can be defined as a method of construction components manufactured in the early environment either outside or in the sites place and install for construction work. The definition of Industrialised Building System (IBS) is further can be interpreted as the construction industry where the system involves the components included in the construction of the building, planning and delivering to the construction site (Kamar, 2013).

Besides, according by Warswaki (1999), the meaning of Industrialised Building System (IBS) all building likes slabs, walls, beams, staircases and columns are produce at control environment like factory and the wet site activities condition is minimum. While, the industrialisation is investment in equipment, facilities and technology with the objective of improving quality, labour resources is minimum and production output is maximize. Whereas, the meaning of building system is a set of interconnected element 10 if that joint together to enable the designated performance of a building.

Based on Lessing et al (2005) also explained Industrialised Building system (IBS) as an integrated construction and manufacturing process with the planning organization for efficient management, control over and preparation the use of resources, results and activities supported by the used of highly develop components. According by Rahman et al (2006), Industrialised Building System (IBS) is the pre-fabricated components are used as a construction system. The mechanical, formwork, machine is used by the components of manufacturing. The components will be sent to construction site for construction and installation purpose.

Classification of Industrialised Building System (IBS)

According by Badir et al. (1998), the Industrialised building System (IBS) can be divided to several aspects such as structural system, material and relative weight. According to Abraham Warszawski (1999), the structural system can be categorizes into three system which are the frame system, panel system and boxes system. Hence, the material system can be categorizes into four system which are the timber, brick and block wall, steel and reinforced concrete (Badir et al 1998). The relative weight of components can be divided into three system which are the frame system likes light weight frame, wood and light gage metals, reinforced plastic and heavy weight frame, the panel system likes light and medium weight panel, wood frame, metal frame and composite material and heavy weight panel and lastly the box system which are the medium weight box, wood frame, light gage metal and composite and the heavy box.

History of IBS

Industrial construction system is said to have been first introduced in the construction industry in our country as early as the 1960s. This can be seen when the built flat houses and several shops in Kuala Lumpur circular road and Jalan Penang Rifle Range. From there, the application Industrialised Building System (IBS) begin to grow, but its use is still on a small scale and focuses on specific construction works such as bridges and tunnels. Now, Industrialised Building System (IBS) begin to receive serious attention by all parties involves with the industrial construction. In fact, the government give strong support to the use of Industrial Building System (IBS) application, especially construction industrial of affordable homes and government buildings**.**

A performance comparison between the methods can be seen in two projects. The performance can be seen in the term of productivity, price, time and quality. According to the research, the first pilot project which is the constructed Jalan Pekeliling in Kuala Lumpur incurred 8.1% higher cost than a similar building and using the method of conventional construction (Thanoon et al, 2003). Whereas, the cost of the second pilot project is lower. In term of the total construction speed, both of the project required 27 month to complete the whole project include the recasting factories to set up (Thanoon et al, 2003). From there, the total quality of building finishes to be better compare than using the conventional construction method.

Besides, another example project that implement the Industrialised Building System (IBS) is public housing project at Taman Tun Sardon in Penang. The total about 1000 units of 5-storey walk up flat that implement the Industrialised Building System (IBS) and this public housing project use the precast component and system. According to the research of Construction Industry Development Board Malaysia (CIDB) 2006, at the same time at Edmonton in North London, there are implement the similar system was constructed and total amount about 20000 dwellings were constructed throughout UK from 1964 until 1974. The total building design was very basic and quite simple and not considering the aspect of serviceability (Rahman and Omar, 2006).

The use of Industrialised Building System (IBS) as a method of construction is evolving in Malaysian construction industry. Nowadays, many local manufacturers have established themselves in the market. Based on PKNS engineering, Setia Precast and Global Globe, many had acquired enough knowledge through technology transfer to build up own capacity in Industrialised Building System (IBS) technologies. The current stage of Industrialised Building System (IBS) used in Malaysia housing projects can be classified into four categories which are steel frame, precast frame, large panel system and formwork system. Then, through the establishment of Industrialised Building System (IBS) at Jalan Chan Sow Lin, Cheras in Kuala Lumpur Industrialised Building System (IBS) move to the next step of the development.

Relationship between the IBS and rural area projects

Therefore, many classification of Industrialised Building System (IBS) in Malaysia. According by Badir et al. (1998), the Industrialised building System (IBS) can be divided to several aspects such as structural system, material and relative weight. But, to use the categories Industrialised Building System (IBS) depends on the project. There are several benefit implementation of Industrialised Building System (IBS) in construction activity.

Although there are several benefit when the Industrialised Building System (IBS) apply on project but most of rural area project use the conventional method compare than the Industrialised Building System (IBS) in the construction activity. The conventional method most popular in rural area projects because the conventional method is the basis method that been used a long time ago. The use of conventional method can cause a many problems like the quality of construction is low, the project take a time to complete and sometimes the project is delay. So, to solve this problem the Industrialised Building System (IBS) should be apply in rural area project.

METHODOLGY

Primary data

The primary data is data obtained directly from individuals who have been identified for use as a respondent in this study. In this cases, the primary data gets from the structured interview using Analytical Hierarchy Process (AHP) pairwise se of questionnaire to the respondents. The respondents in this study is the lecturers in University Utara Malaysia (UUM) who have an experience in the construction industry.

Secondary data

The secondary data can be defined as existing data or information that could be used as references material to increase the information obtained from the primary data. In this study, the secondary data obtained from the library research which is to acquire a various book resources, academic journal, previous research studies, and website.

Analytical Hierarchy Process (AHP)

In the 1970s, the analytic hierarchy process (AHP) method was developed by Tomas L. Saaty. According by Thomas L. Saaty, this method have produced to define the problem with associated with the multi criteria decision making. The analytic hierarchy process (AHP) is an effective tool for dealing with complex decision making, and may aid the decision maker to set priorities and make the best decision. In addition to goal programming, the analytic hierarchy process (AHP) is another multi criteria decision making method. The analytic hierarchy process (AHP) can be used if we want to decide the rank order of decision alternatives or select an alternative from a set of alternatives based on multiple criteria. In this case, the AHP use to ranking the barriers of IBS in rural area projects according to the prioritization.

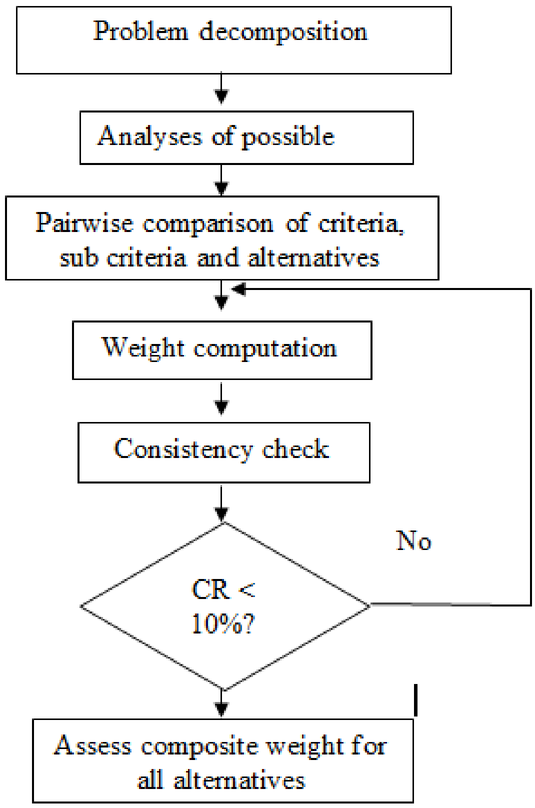

Figure 1: The Analytical Hierarchy Process algorithm

Based on figure 1, the analytic hierarchy process (AHP) is based on three key steps which are decomposition, comparative judgments and synthesis of priorities (Korpela and Tuominen, 1996). The decomposition is carried out by solving complex problems into several elements in a way that hierarchy like the goal, criteria, sub criteria, and alternatives. This method is most important in simplifying decision making. The purpose of the judgement comparison is to determine the relative importance of each element in each stage hierarchy through pairwise comparison. A consistency check is performed to make sure that all the inferences made from the analytical hierarchy process (AHP) are indeed valid. Then, the synthesis priorities should be done to assess the composite weight of each decision alternatives.

DATA ANALYSIS

In the Analytical Hierarchy Process (AHP), that have two level which are level one is the main criteria and level two is sub-criteria for the main criteria.

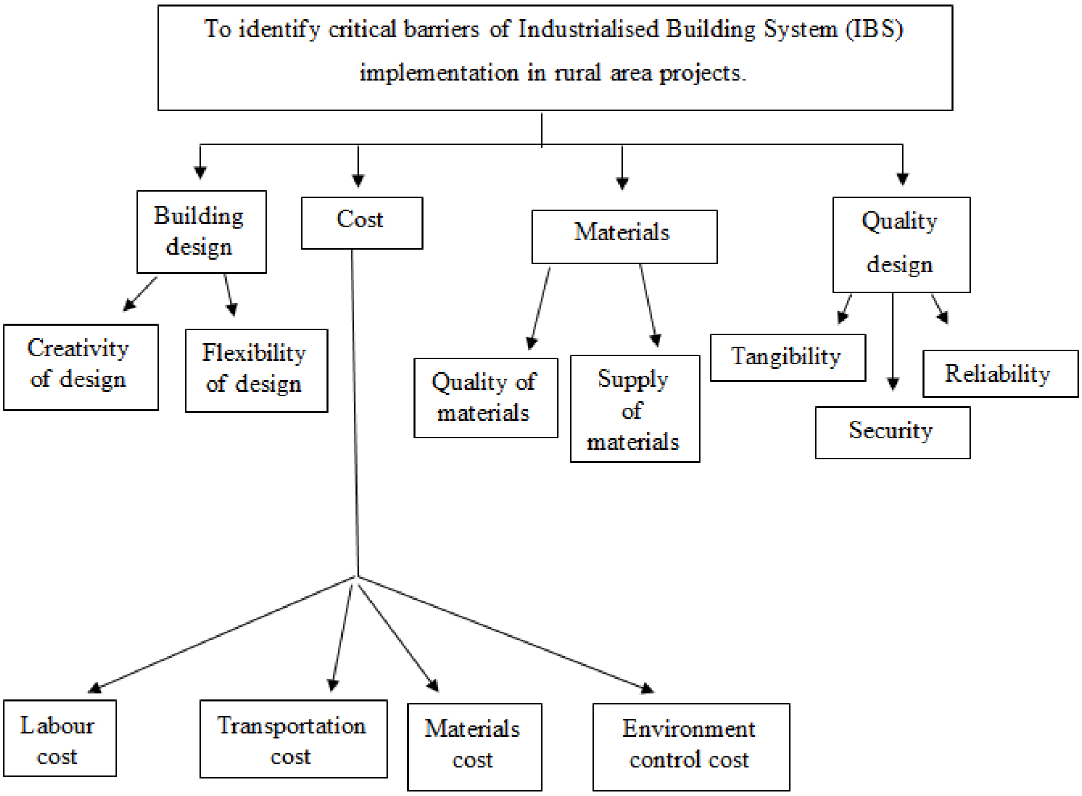

Figure 2: The main criteria and the sub-criteria

The figure 2 shows the main criteria and the sub criteria for the critical barriers of Industrialised Building System (IBS) in rural area projects. The aim of the study is to determine the most critical barriers to IBS implementation in rural area projects. So, from the figure above, the main criteria for the barriers of IBS are the quality design, cost, materials and the building of design. Hence, the sub-criteria for the barriers of IBS are security, tangibility, reliability, labour cost, materials cost, environment control cost, transportation cost, quality of materials, supply of materials, flexibility design and creativity design. In AHP, all the criteria are important but we want to know the most important criteria and sub criteria. In this case, we want to find the most important barriers to IBS implementation in rural area projects. The pairwise comparison is performed on the basis of how the criteria dominate the other and the judgement are entered using the Saaty's 1-9 scale. The respondent start to compare each pair of main criteria with respect to the main goal by assigning the importance. The measurement scale develop by Saaty's divide by six parts which are the equally preferred, moderately more preferred, strongly more preferred, very strongly more preferred, extremely more preferred, and intermediate value based on the table 1 below. Expert choice software package was used to carry out such comparison.

Table 1: Measurement scales of the level of importance.

Level of importance	Denotation	Definition
1	Equally preferred	Both factors in consideration are equal importance
3	Moderately more preferred	Experience and judgement shows a slightly more preferences of one factor than the other
5	Strongly more preferred	Experience and judgement strongly favour one factor over another
7	Very strongly more preferred	An activity is favoured very strongly over another, its dominance demonstrated in practice
9	Extremely more preferred	The evidence favouring one activity over another is of the highest possible order of affirmation.
2,4,6,8	Intermediate values	When compromise is needed. Judgement can reveal an evenly matched preference between the levels of importance

Table 3: The resulting contribution of main criteria and sub-criteria to main goal.

Rank	Ranking of criteria and sub-criteria	Percentage (%)
1	Quality design	38
2	Cost	27.3
3	Materials	24.9
4	Security	20.5
5	Labour cost	14.7
6	Environment control cost	13.5
7	Quality of materials	13.4
8	Material costs	10.2
9	Building design	9.9
10	reliability	7.4
11	Transportation cost	6.6
12	Flexibility design	5.3
13	Tangibility	4.1
14	Supply materials	3.2
15	Creativity design	1.2

Table 3 presents the ratio of each criterion, where the quality design is evidently the most important factor in the presented case study with the total aggregate weight of 38% and followed by cost which is 27.3%, the materials is 24.9%, the security is 20.5%, the labour cost is 14.7%, the environment control cost is 13.5%, the quality of materials is 13.4%, the material cost is 10.2%, the building design is 9.9%, the reliability of building is 7.4%, the transportation cost is 6.6%, the flexibility of design is 5.3%, the tangibility of building is 4.1%, the supply of materials is 3.2% and the creativity of design factor shown to be the least important carrying a percentage only 1.2%. The overall inconsistency value is 0.03, this ratio is still acceptable and the judgement are undoubtedly consistent because the ratio not more than 1. The result determine by respondent through the AHP pairwise set of questionnaire.

On the whole, the critical barriers to IBS implementation in rural area projects is quality design. The implementation of Industrialised Building System (IBS) in construction industry definitely can produce a high quality of building in term of the security, tangibility and reliability of building. Indeed, the design of IBS itself that produce the best quality to building. Although, the quality design using IBS can give a high quality but the clients in rural area projects more trusting the construction using conventional method especially in term of security because the clients already familiar with the conventional method compare than IBS since long ago. So, the contractors are often in doubt using IBS because of fear of client rejection in rural rea projects.

Then, followed by cost which is 27.3%. This mean that the cost also the critical barriers to IBS implementation in rural area projects. The cost of IBS include all the cost to build a building using of IBS likes the labour cost, environment control cost, material cost and the transportation cost. So, the high cost required to build a building using IBS especially the transportation cost. The high transportation cost is required to carry out the components of IBS from factory to the site in rural area. This situation can cause a clients or contractors not interesting to build a project using of IBS in rural area projects.

The table above show the least importance factor in the presented case study is creativity of design. This means the creativity of design using IBS is not an obstacle to implement of IBS in rural area projects. The creativity design of IBS still acceptable by clients and contractors in rural area projects. In this case, the supply of material to produce the components of IBS easy to gets. The supply of materials also not an obstacle to use of IBS in rural area projects.

CONCLUSION AND RECOMMENDATION

The construction industry was the catalyst for Malaysia to achieve the desire to become a develop country. Now, the country are entering an area globalization that requires high technology to enable the occurrence of competition with develop countries to another. The industry construction should be change from labour intensive sectors to the Industrialised Building System (IBS) include the rural areas. So, the most critical barriers of IBS in rural area projects should be analysis and find the best solution to solve the problem.

The Analytical Hierarchy Process (AHP) is the expert model works adequately and yields acceptable results as well as dragging accurate decisions in most critical barriers to IBS implementation. It was made clear from the output of Expert Choices for each criteria, that most of the area of the AHP priority stack is occupied by quality design and security criteria, thus, showing the most critical barriers to IBS implementation in rural area projects. The quality design and security factor that preventing the implementation of IBS in rural area projects. The pairwise assessment through the verbal scaling made it easy for the expert to disseminate respondent comprehension and eventually reveal more representing knowledge and decision.

So, this study beneficially to the policy makers or company may use the findings or guideline to formulate new policy or strategy. But, there are limitation from this study which is the idea cannot be generalize because the number of respondent involves is small. In future, the number of respondent is involves should be large to generalize the idea.

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